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The relationship between physiological and perceived fall risk in people with multiple sclerosis: implications for assessment and management

Gunn, Hilary

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Authors: Hilary Gunn PhD[1*], Michelle Cameron MD[2], Phu Hoang PhD[3,4], Stephen Lord PhD[3], Steve Shaw PhD[1], Jennifer Freeman PhD[1]

Academic Institutions:

1: School of Health Professions, Plymouth University, UK

2: Oregon Health & Science University and VA Portland Health Care Service, Portland, Oregon, USA

3: Neuroscience Research Australia, Sydney, Australia

4: Australian Catholic University, Sydney, Australia

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1

Title: The relationship between physiological and perceived fall risk in people with multiple sclerosis: implications for assessment and management

Abstract

Objective

This study evaluated the relationship between physiological and perceived fall risk in people with MS.

Design

Secondary analysis of data from prospective cohort studies undertaken in Australia, United Kingdom and the United States.

Setting

Community

Participants

416 ambulatory people with MS (age 51.5 ±12.0 years; 73% female; 62% relapsing-remitting MS; 13.7 ±9.9 years disease duration).

Interventions

Not applicable

Outcome measures

All participants completed measures of physiological (Physiological Profile Assessment (PPA)) and perceived (Falls Efficacy Scale-international (FESi)) fall risk and prospectively recorded falls for three months.

Results

155 (37%) of the participants were recurrent fallers (≥2 falls). Mean PPA and FESi scores were high (PPA 2.14±1.87, FESi 34.27±11.18). The PPA and the FESi independently predicted faller classification in logistic regression, which indicated

that the odds of being classified as a recurrent faller significantly increased with increasing scores (PPA Odds Ratio 1.30 (95%CI 1.17-1.46), FESi Odds Ratio 1.05 (95% CI 1.03-1.07)).

Classification and regression tree analysis divided the sample into four groups based on cut-off values for the PPA: (1) low physiological/ low perceived risk (PPA <2.83, FESi <27.5), (2) low physiological/ high perceived risk (PPA <2.83, FESi >27.5), (3) high physiological/ low perceived risk (PPA >2.83, FESi <35.5), and (4) high physiological/ high perceived risk (PPA <2.83, FESi >35.5). Over 50% of participants had a disparity between perceived and physiological fall risk; most were in group 2. It is possible that physiological risk factors not detected by the PPA may also be influential.

Conclusion

This study highlights the importance of considering *both* physiological and perceived fall risk in MS, and that further research is needed to explore the complex inter-relationships of perceptual and physiological risk factors in this population. This study also supports the importance of developing behavioral and physical interventions which can be tailored to the individual’s need.

300 words

Keywords: Multiple sclerosis; Accidental falls; Physiological balance; Rehabilitation; Cohort study

Abbreviations:

AUS: Australia: CART: Classification and Regression Tree; EDSS: Expanded Disability Status Scale; MS: Multiple sclerosis; PPA: Physiological Profile

Assessment; SWIMS: South-West Impact of MS study; UK: United Kingdom; US: United States

Introduction

Multiple sclerosis (MS) affects approximately 2.3 million people worldwide[1]. People with MS consistently report impaired mobility is one of their most concerning problems[2], impacting not only access to the community but also quality of life[3]. Impaired balance and falls are common in people MS and contribute to mobility loss[4,5]. Given the significant economic, personal, and social costs associated with impaired mobility, balance and falls[3], effective interventions are a high priority[6].

Evidence from other populations suggests that individualised fall risk-factor identification is important for developing targeted interventions to optimise rehabilitation outcomes[7]. Identified risk factors for falls in people with MS include physiological attributes such as gait disturbance, spasticity, slow reaction time, and increased postural sway[8,9] as well as psychological factors such as fear of falling[12] and reduced falls self-efficacy[13 12]. The Physiological Profile Assessment (PPA), a standardised five-item test of sensorimotor and balance performance which includes measures of proprioception, reaction time, visual contrast sensitivity, muscle strength, and postural sway, can measure physiological contributors to fall risk[13]. Although the PPA was originally developed to assess fall risk in older adults, it has been validated in people with MS, where scores show moderate correlation with fall risk[8,9]. MS specific, age adjusted reference values for the PPA composite scores have also been established[14]. The Falls Efficacy Scale-international (FESi)[15], a 16 item questionnaire, is recommended as a measure of perceived risk of falls. The FESi has established validity and reliability in people with MS[16,17] and FESi scores are associated with prospectively recorded falls in this group (Odds Ratio (OR) 1.22, 95% Confidence Interval (CI) 1.04-1.43)[18].

In some people, physiological and perceived fall risk differ. Delbaere et al. highlighted such disparities in a cohort of community dwelling older adults[19]. They proposed categorizing individuals into four distinct groups based on their physiological fall risk as measured by the PPA, and their perceived fall risk as measured by the FESi. This study also identified cut-off points in the two measures to identify the different groupings. These findings are relevant to practice, and may inform patient management. For example, providing challenging balance exercise to people with high perceived risk but relatively low physiological risk may heighten their feelings of concern, and potentially reduce engagement in the program. In contrast, approaches aimed at increasing self-efficacy and use of falls management strategies are unlikely to be effective in people who do not perceive themselves to be at high risk of falling.

Although there is increasing evidence identifying MS-specific risk factors for falling, little is currently known about the relationship between perceived and physiological fall risk. Our aim was to evaluate this relationship using a similar methodology to Delbaere et al.[19]. The specific objectives were to assess whether there are disparities between perceived and physiological fall risk in people with MS, and to explore potential contributory factors. The findings could be used to guide individualised assessment and development of tailored fall risk management strategies.

Methods

Data Sources

This analysis used data from prospective cohort studies of falls and fall risk in people with MS carried out in Australia (AUS)[8], the United Kingdom (UK)[9] and the United States (US)[20]. All relevant local ethical permissions were obtained for all three studies (AUS: HC09253; UK: 10/H0203/66 and US: E7244W). All participants gave written informed consent.

Participants

Study participants were 416 people with MS (210 AUS, 148 UK and 58 US) diagnosed by standardized criteria[21,22] and aged 18 years and older. All MS subtypes were included. In the UK and the US samples, disease severity was measured using the Expanded Disability Status Scale (EDSS)[23], assessed either face-to-face by a trained clinician or using the self-report EDSS by telephone interview[24]. In Australia, the Disease Steps Scale[25] was used during a face-to-face assessment and converted to EDSS by mobility criteria[26].

Common exclusion criteria were inability to understand and sign an informed consent or being unable to follow test instructions. Additional local inclusion criteria were:

- Australia: ability to stand unsupported for 30 seconds and walk 10 metres with or without a mobility aid (i.e. Disease Steps 0-5).
- UK: EDSS score between 3.5 and 6.5.

- US: EDSS score of 6.0 or less, upper age limit of 50, relapse free for 30 days prior to baseline examination.

Recruitment

The Australian sample was recruited in a single out-patient MS physiotherapy clinic in Sydney. The UK sample was recruited via invitation letters from their local neurologist and an advertisement in the newsletter of the South West Impact of MS (SWIMS) project[27] which is accessed by over 1500 people with MS living in the South West of England. The US sample was recruited from specialty MS center outpatient clinics at a Department of Veterans Affairs medical centre, a university medical centre in the Northwest of the United States and the surrounding community.

Measures

Demographic data including age, gender, years since MS diagnosis, MS subtype, use of walking aids, and retrospective fall history were collected at baseline using a structured questionnaire.

<u>Physiological fall risk: Physiological Profile Assessment (PPA)</u>

The PPA was developed as a low-tech, clinically feasible method to assess fall risk[13] in older adults and has been shown to predict falls in people with MS[8,9]. The five components of the PPA are: (1) proprioception, measured with a lower limb matching task; (2) quadriceps muscle strength, measured isometrically in the dominant leg while participants are seated; (3) simple reaction time, measured with a light as stimulus and a finger press response; (4) visual contrast sensitivity as measured by the Melbourne edge test; and (5) postural sway, measured with a sway meter recording displacements of the body at the level of the pelvis while participants stand on a foam rubber mat with eyes open. The five PPA components are weighted to compute a composite PPA fall-risk score expressed in standard (z-score) units; with higher scores indicating worse performance.

Perceived fall risk: Falls Efficacy Scale–international (FESi)[15]

The FESi is a 16-item questionnaire that asks participants to indicate their level of concern about falling for a range of activities of daily living (such as cleaning the house or going out on a social event). Each activity is scored on a four-point scale (1 = not at all concerned to 4 = very concerned).

Falls

Falls were assessed retrospectively and prospectively. For retrospective assessment participants were asked if they had fallen in the previous three months (yes or no). For prospective assessment, participants recorded falls in the subsequent three months using a daily diary[28]. Participants received falls diary sheets, written instructions and reply-paid return envelopes; in AUS and USA these were returned monthly, the UK diaries were returned every two weeks. A reminder telephone call or email was sent to participants whose diary returns fell behind schedule[28]. In AUS, a fall was defined as ‘‘unintentionally coming to the ground or other lower level and other than as a consequence of sustaining a violent blow, loss of consciousness, or sudden onset of paralysis as in stroke or epileptic seizure’’[29]. In the UK and US, a fall was defined as ‘‘a slip or trip in which participants came to rest on the ground or floor or lower level’’[15]. In line with recommendations, recurrent fallers were defined as those who fell twice or more in the three month retrospective and prospective periods[30].

Data analysis

All statistical analyses were performed using SPSS V23 (IBM, Chicago, USA). Data were summarized using frequencies and percentages, mean and standard deviation or median and interquartile range (IQR) as appropriate. Given the low numbers of missing data, missing values were imputed using the overall mean from the rest of the sample[31].

Baseline differences between the three geographical samples were assessed by either univariate analyses of variance (ANOVA) or by χ^2 tests. Subsequently, logistic regression was used to calculate univariate and bivariate odds ratios for the associations between physiological fall risk (PPA) and perceived fall risk (FESi) with fall classification.

A classification and regression tree (CART) analysis was undertaken to develop a framework to classify participants into groups based on their physiological and perceived fall risk. CART analysis aims to develop subsets of a data set, which are as homogenous as possible with respect to the target variable, through repeated analyses based on predictor variables[32]. Confirmation of the CART model was performed using cross-validation methods[33]. Subsequently, the associations between the CART groupings were explored. For categorical variables, the groupings were analysed using Fishers exact test. For continuous variables, the differences between the CART groups were compared using ANOVA, with between group comparisons analysed using a Bonferroni corrected *p* value.

Results

A total of 416 participants were included in the analyses. Of these, 10 (<3%) had missing FESi data. Participants had a mean age of 52 years (range 21-84 years), 305 (73%) were female, and 257 (62%) were classified as having relapsing-remitting MS (table 1). Approximately one third (155 participants, 37.3%) reported ≥2 falls in the three-month follow-up periods. There were significant differences between the cohorts for all characteristics except gender.

Insert table 1 about here

Association between PPA/FESi and prospective falls

Univariate logistic regression confirmed higher PPA and FESi scores increased the odds of being classified as a recurrent faller (PPA OR 1.30 (95%CI 1.17-1.46, FESi OR 1.05 (95% CI 1.03-1.07). Bivariate regression analysis demonstrated that both the PPA and FESi scores were independent predictors of recurrent falls, with PPA making the greater contribution to the model (standardised B, table 2). An overall indication of goodness of fit of the model was obtained through the use of the Hosmer and Lemeshow statistic. The non-significant result of χ^2 10.87, df 8 p=0.21 indicates there is no evidence of lack of fit based on this statistic.

Insert table 2 about here

Classification and regression tree analysis

The CART analysis divided the sample into four groups (figure 1).

- Group 1: low physiological risk/low perceived risk;
- Group 2: low physiological risk/high perceived risk;
- Group 3: high physiological risk/low perceived risk;
- Group 4: high physiological risk/high perceived risk

The model and cross-validation samples performed similarly, with an overall model error rate of 0.31 (Standard error (SE) 0.02), compared with the cross-validation error rate of 0.35 (SE 0.02). The PPA cut-off point for splitting the group into low and high physiological risk was 2.83. This cut-off point classified most participants (69% (n=288)) as having 'low' physiological fall risk. The cut-off point to distinguish low and high levels of perceived fall risk using the FESi differed according to physiological risk; for those with a low physiological risk the FESi cut-off point was 27.5, whilst for those with a high physiological risk the cut-off point was 35.5.

The two largest groups comprised participants with a high perceived fall risk (Groups 2 and 4). In Group 4 (high physiological risk/ high perceived risk), 55 (64%) prospectively reported two or more falls, suggesting that these individuals were insightful about their level of risk. In contrast, in Group 2 (low physiological risk/ high perceived risk), 106 (63%) prospectively reported fewer than 2 falls. As with Group 4, most of the participants in Group 1 (low physiological/ low perceived risk) appeared to have an accurate perception of their fall risk, as 84% (n=100) had fewer than 2 falls in the recording period. The smallest group were those classified as having high physiological risk, but low levels of perceived fall risk (Group 3, n=42). Of these, 18 (43%) were classified as recurrent fallers.

Insert Figure 1 about here

Associations between CART groupings and participant characteristics (table 3)

Participants in Group 1 (low physiological risk/ low perceived risk) were, on average, younger (mean age 47.2 (SD 12.6)) and less disabled (group median EDSS 2.5, IQR 2.0-3.5) than in the other groups. In contrast, Group 2 participants (low physiological risk/ high perceived risk) were more likely to report having fallen in the previous year than those in Group 1 (113 (67%) fallers in Group 2 compared with 56 (47% in Group 1), and had similar rates of walking aid use to Groups 3 and 4 (those classified at high physiological risk of falling). Groups 3 and 4 were similar to each other except that Group 4 participants were more likely to report using a walking aid. The distribution of participants amongst the CART groupings varied with recruiting site, with proportionally more participants from the USA in Group 1, and a greater proportion of UK participants in Groups 2 and 4.

Insert table 3 about here

Discussion

To our knowledge this paper presents the first analysis of the relationship between physiological and perceived fall risk and prospectively reported falls in people with MS. The cohort included ambulatory people with a range of disability levels and all MS subtypes.

Our cohort's mean PPA score was 2.14 (SD 1.87), mean FESi score was 34.27 (SD 11.18) and 37.3% of the group fell at least twice in 3 months. These values are all high compared to similar aged healthy individuals[14], and other groups at increased risk of falling (including people following a stroke[34] and older adults[35]). The mean PPA and FESi values in this cohort were also higher than those reported in other MS cohorts (e.g. Sosnoff et al[36] and Carling et al[37]). These differences most likely relate to differences in sample characteristics. Our study had a higher proportion of people with SPMS than Sosnoff et al's cohort[36] (proportion of people with SPMS 24% vs. 15%) and a lower average EDSS than Carling et al's cohort[37] (Median EDSS 4.0, IQR 2.5 vs. 6.0, IQR 3.5).

The CART analysis categorized the cohort into four groups based on physiological and perceived fall risk scores and identified cut-off values for high and low risk. These cut-off values are higher than those obtained in Delbaere's analysis in older adults[19]. It is possible that this is because our MS cohort were able to develop strategies to manage their physical impairments more effectively to avoid falls than older people. However, the high overall values of perceived fall risk highlight that falls are an 'ever present reality' for most people with MS[38,p151], thus the cut-off to differentiate those with a 'high' or 'low' perceived fall risk is made against a background of high concern across the cohort. As cut-off values to distinguish fallers and non-fallers in the PPA or FESi have not previously been reported in MS, further research to explore the validity of our results, particularly of the proposed cut-offs, is recommended.

In our analysis, over half of the participants had disparities between physiological and perceived risk (i.e. those in Groups 2 and 3). This is in contrast to Delbaere's study, where over two thirds had concurrent physiological and perceived fall risk[19]. Various factors could underlie the greater disparity in our cohort. Importantly, cognitive impairment, which is common in people with MS[39], may have contributed to the disparity between physiological and perceived risk factors. Whilst all three samples collected cognitive data, variations in the measures used meant we were unable to include this factor in our study. Exploration of this in future studies is important as it is likely that this could influence management.

In our analysis, 63 (37%) of the participants in Group 2 (low physiological/ high perceived risk) were classified as recurrent fallers, which represents 41% of recurrent fallers across the whole cohort. Although these individuals were classified by the PPA as having 'low' physiological risk, the cut-off point (2.83) was relatively high and it is likely that for at least some of them, physiological factors in addition to those assessed by the PPA contributed to fall risk. For example, impaired gait, spasticity and dual task interference have all been identified as fall risk factors in prospective MS cohort studies but are not captured by the PPA[8,9,12]. It is essential that the complexity of factors contributing to risk of falls is recognised during the assessment process and when developing falls management interventions.

Conversely, over 60% (n=106) of Group 2 (low physiological/ high perceived risk) did not report recurrent falls. Despite the moderate level of disability within this group (median EDSS 4.0 (IQR 2.5-5.5)), 107 people (63%) reported using walking aids, which was a similar proportion to those doing so who were classified at high physiological risk of falls. Whilst the three-month reporting period may have been too short to capture recurrent falls in some individuals, it could be that the high level of perceived risk made people take less risk. This emphasises the importance of evaluating individual's perceptions, alongside early education about fall prevention, with a key aim of maintaining physical activity levels and avoiding activity curtailment[40,41]. Accurate long-term monitoring, and interventions focused on increasing confidence and knowledge about effective risk management could be particularly appropriate for these individuals.

While perceived risk was greater than physiological risk for most participants with a disparity, 42 (10%) individuals were classified as having a high physiological risk but low perceived fall risk (Group 3). Within this group, over half reported no falls, suggesting their lower levels of concern were probably justified, for example they may have adopted effective fall prevention strategies. However, given the high mean PPA in this group, it is likely that encouraging the non-recurrent fallers to address modifiable risk factors would still be warranted to prevent future falls. In contrast, 18 individuals in Group 3 reported recurrent falls. Identifying people who see themselves as being at unduly low risk is important, since it is known that the perceived relevance of a programme influences engagement[42–44]. For these individuals, it may be that management could initially focus on identifying problems with balance and stability before then supporting the participant to undertake appropriate risk management decisions based on an accurate assessment of their physical ability.

Individuals in Groups 1 and 4 were classified as having concurrent physiological and perceived fall risk. Within Group 1, some participants reported falling despite being classified as having both low physiological and low perceived risk of falling. These participants, on average, were relatively young with a low disease severity. It is postulated that an early intervention approach, which emphasizes health promotion alongside preventative strategies, would be beneficial for this group to minimise the long-term negative impact that falls may have on participation levels and quality of life. Group 4 participants had the highest level of disability, greatest proportion of individuals with progressive MS and the highest proportion of people reporting having fallen in the past year. It is likely that falls management interventions for these individuals would need to address multiple risk factors, carefully balancing benefit and burden.

Study Limitations

This study has several limitations. Firstly, our cohort comprised participants who were recruited to separate studies in three countries. It is likely that the variations in recruitment criteria and baseline characteristics between the groups contributes to the different proportions of participants from each country seen in the CART analyses, however, other social or geographical factors cannot be discounted.
In addition, our sample did not include any individuals with an EDSS >6.5. It is likely that the factors contributing to falls in non-ambulatory individuals are different from those in ambulatory individuals[45]. The findings may therefore not generalize to people whose mobility is severely affected. In addition, while our analysis was able to explore the relationship between physiological and perceived fall risk as indicated by the PPA and the FESi, both of these measures do not capture all of the complex

factors contributing to fall risk in MS. Given the high rate of comorbidities[46], and the prevalence of issues such as cognitive dysfunction and depression[39], further exploration is warranted. In addition, limitations in the PPA and the FESi could result in inaccurate classification for some individuals. For example, the PPA may not detect subtle balance deficits that can be captured by instrumented tests[47] and, may not capture MS-specific physiological risk factors (e.g. spasticity, internuclear ophthalmoplegia), that may be significant. Finally, it is important to emphasize that, while this analysis presents cut-off points which classify individuals into groups based on physiological and perceived fall risk, the results represent an *estimate* of values which could differentiate those at lower and higher risk. Our intention was to provide an initial exploration of the relationship between physiological and perceived fall risk in MS, and to suggest ways that assessment findings could be used to inform therapists' management plans. It is likely that other factors, not included within our analyses, such as cognition, disability level and physical environment, may also influence falls. Additional work to evaluate the relationship between the multiple factors that are likely to influence risk of falling and engagement with fall prevention activities is essential.

Conclusion

These findings highlight the importance of considering both physiological and perceived fall risk when evaluating people with MS. Whilst both the PPA and the FESi independently predicted falls in this cohort, the subsequent classification and regression tree analysis highlighted an interrelationship between the two factors which could have important implications for management. These findings are consistent with the geriatrics literature and its growing focus on targeted, individualized fall prevention, addressing both factors[48]. These findings also underline the complexity of falls in MS and the importance of detailed description, evaluation and targeting of fall prevention interventions to optimize their effectiveness.

3695 words

Conflict of interests

Stephen Lord declares the Physiological Profile Assessment (NeuRA FallScreen) is commercially available through Neuroscience Research Australia.

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Figure Legends

Figure 1: Classification tree

*: "non-fallers" in this figure are those who reported ≤1 fall in the three-month reporting period

Table 1: Sample Characteristics

	Australia (n=210)	United Kingdom (n=148)	United States (n=58)	Total sample (n=416)
Age in years: Mean (range)^{*a}	50.3 (21-73)	58 (33-84)	39.5 (22-50)	51.5 (21-84)
Gender F:M Ratio (%)$^{ns;\ b}$	150:60 (71:29)	114:34 (77:23)	41:17 (71:29)	305:111 (73:27)
Years with MS: Mean (SD)^{*a}	13.6 (8.9)	16.7 (10.9)	6.5 (5.8)	13.7 (9.9)
EDSS: Median (IQR) ^{*a}	3.5 (2.0-5.0)	5.5 (4.0-6.0)	3.0 (1.5-3.5)	4.0 (2.5-5.5)
Subtype: n (%)^{*b}				
RRMS	160 (76.2)	42 (28.4)	55 (94.8)	257 (61.7)
SPMS	30 (14.3)	66 (44.6)	3 (5.2)	99 (23.8)
PPMS	19 (9.0)	37 (25)	0	56 (13.5)
Unknown	1 (0.5)	3 (2)	0	4 (0.9)
Mobility Aid Use: Y: N Ratio (%)^{*b}	100:110 (48:52)	110:38 (74:26)	9:49 (16:84)	219:197 (53:47)
Retrospective falls history: Y:N (%)^{*b}	152:58 (72:28)	85:63 (57:43)	30:28 (52:48)	267:149 (64:36)
Prospective falls history (3 months) n (%)^{*b}				
0 falls	122 (58)	44 (30)	24 (41)	190 (46)
1 fall	31 (15)	26 (18)	14 (24)	71 (17)
2+ falls	57 (27)	78 (52)	20 (35)	155 (37)
PPA: Mean (SD) ^{*a}	2.32 (1.91)	2.45 (1.75)	0.74 (1.37)	2.14 (1.87)
FESi: Mean (SD) ^{*a}	34.93 (11.40)	37.06 (9.84)	25.59 (9.27)	34.37 (11.18)

F: Female; M: Male; n: Number; Y: Yes; N: No; SD: Standard Deviation; IQR: Inter-quartile range; EDSS: Expanded Disability Status Scale; RRMS: Relapsing-Remitting MS; SPMS: Secondary Progressive MS; PPMS: Primary Progressive MS; PPA: Physiological Profile Assessment; FESi: Falls Efficacy Scale (international);ns: no significant differences between the samples; *: significant differences between the samples; a: ANOVA; b: χ^2

Table 2: Logistic regression analysis examining association between physiological fall risk and perceived fall risk

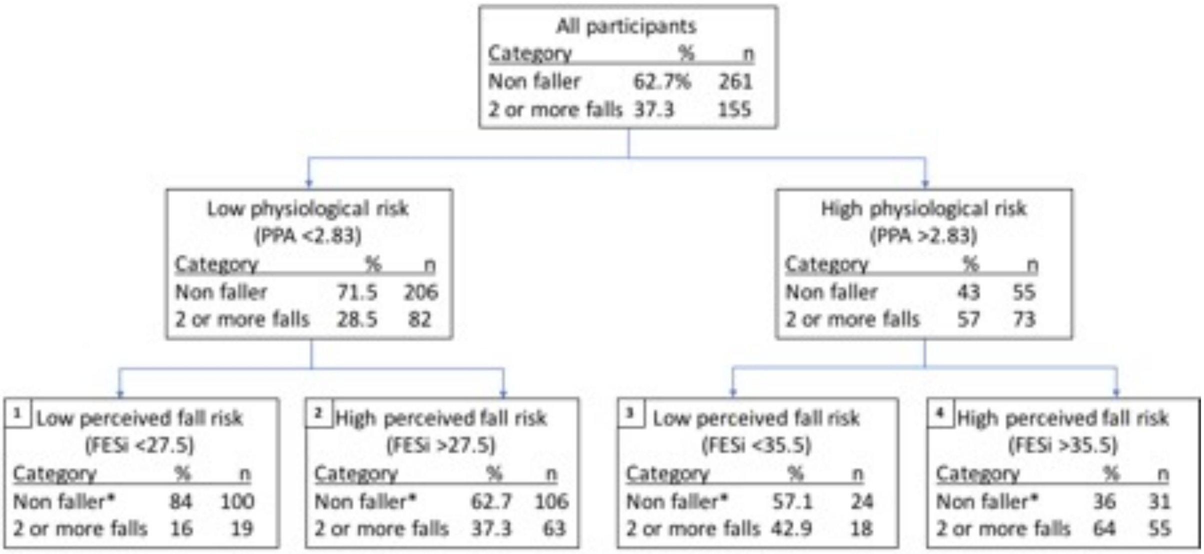
	B	S.E.	Wald	df	*p*	OR (95% CI)
PPA	0.196	0.061	10.51	1	0.001	1.217 (1.08-1.37)
FESi	0.034	0.010	10.64	1	0.001	1.035 (1.01-1.06)
Constant	-2.152	.367	34.47	1	<0.001	0.116

B: Standardised β coefficient; SE: Standard error; df: Degrees of freedom; OR: Odds ratio; CI: Confidence interval; PPA: Physiological Profile Assessment (physiological fall risk); FESi: Falls Efficacy Scale-international (perceived fall risk)

Table 3: Analysis of Classification and Regression Tree (CART) groupings

	Low physiological fall risk			High physiological risk		
	Low perceived risk (n=119)	High perceived risk (n=169)	P value of difference	Low perceived risk (n= 42)	High perceived risk (n=86)	P value of difference
PPA (mean (SD))	0.77 (1.00)	1.38 (0.90)	<0.001[a]	4.54 (1.41)	4.47 (1.27)	0.75[a]
FESi (mean (SD))	22 (3.41)	38.7 (7.39)	<0.001[a]	29 (4.71)	47 (6.99)	<0.001[a]
EDSS (median (IQR))	2.5 (2.0-3.5)	4.0 (3.0-5.5)	<0.001[a]	4.75 (3.5-6.0)	5.5 (4.0-6.0)	0.01[a]
Age (mean (SD))	47 (12.6)	53 (11.2)	<0.001[a]	54 (11.21)	55 (10.90)	0.57[a]
Type of MS (n (%))						
PP	6 (5)	28 (17)	<0.001[b]	6 (14)	16 (19)	0.31[b]
RR	103 (87)	97 (57)		23 (55)	34 (40)	
SP	9 (7)	42 (25)		13 (31)	35 (41)	
Unknown	1 (1)	2 (1)		-	1 (1)	
Walking aid (n (%))						
No aid	99 (83)	62 (37)	<0.001[b]	17 (40)	19 (22)	0.07[b]
Any aid	20 (17)	107 (63)		25 (60)	67 (78)	
Self-report of any falls in the past year (n (%))						
No falls	63 (53)	56 (33)	0.001[b]	12 (29)	18 (21)	0.37[b]
≥1 fall	56 (47)	113 (67)		30 (71)	68 (79)	
Gender (n (%))						
Male	37 (31)	43 (25)	0.35[b]	8 (19)	23 (27)	0.38[b]
Female	82 (69)	126 (75)		34 (81)	63 (73)	
Site (n (%) of cohort in each CART group)						
Australia	59 (28)	82 (39)	<0.001[b]	25 (12)	44 (21)	0.32[b]
UK	21 (14)	72 (49)		16 (11)	39 (26)	
USA	39 (67)	15 (26)		1 (2)	3 (5)	

[a]: analysis using ANOVA; [b]: analysis using Fisher's exact test;


All participants
Category % n
Non faller 62.7% 261
2 or more falls 37.3 155
Low physiological risk
(PPA <2.83)
Category % n
Non faller 71.5 206
2 or more falls 28.5 82
High physiological risk
(PPA >2.83)
Category % n
Non faller 43 55
2 or more falls 57 73
1 Low perceived fall risk
(FESi <27.5)
Category % n
Non faller* 84 100
2 or more falls 16 19
2 High perceived fall risk
(FESi >27.5)
Category % n
Non faller* 62.7 106
2 or more falls 37.3 63
3 Low perceived fall risk
(FESi <35.5)
Category % n
Non faller* 57.1 24
2 or more falls 42.9 18
4 High perceived fall risk
(FESi >35.5)
Category % n
Non faller* 36 31
2 or more falls 64 55